Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel Level 3 Certificate

Tuesday 6 June 2023

Afternoon (Time: 1 hour 40 minutes)

Paper reference **7MC0/01**

Mathematics in Context

PAPER 1: Comprehension

You must have:
Ruler graduated in centimetres and millimetres, pen, HB pencil, eraser, calculator. Source booklet.

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided
  – *there may be more space than you need.*
- **Calculators may be used.**

Information

- The total mark for this paper is 60
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question.*

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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SECTION A

Answer ALL questions. Write your answers in the spaces provided.

FOOTBALL

Refer to **data source A** in the source booklet for Questions 1 and 2.

1 (a) (i) What fraction of the Premier League games played in the 1998–99 season were shown live on TV?

(1)

In the 2016–17 season, fewer than half of the Premier League games were shown live on TV.

(ii) How many fewer games?

(2)

(b) (i) Show that the cost of the TV broadcasting rights per game during the period 1992–97 was approximately £600 000

(2)

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(ii) Calculate the percentage change in the cost of the TV broadcasting rights per game from 1992–97 to 2016–19.

(4)

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Rob uses a spreadsheet to calculate the facility fees paid to the clubs in the Premier League in the 2017–18 season.

	A	B	C
1	**Club**	**Number of live TV games shown**	**Facility fee (£ million)**
2	Manchester City	26	= 12.3 + 1.12 * (B2 − 10)
3	Manchester United	28	= 12.3 + 1.12 * (B3 − 10)
4	Tottenham Hotspur	25	= 12.3 + 1.12 * (B4 − 10)
5	Liverpool	28	= 12.3 + 1.12 * (B5 − 10)
6	Chelsea	26	= 12.3 + 1.12 * (B6 − 10)
7	Arsenal	28	= 12.3 + 1.12 * (B7 − 10)
8	Burnley	7	= 12.3 + 1.12 * (B8 − 10)
9	Everton	19	= 12.3 + 1.12 * (B9 − 10)
10	Leicester City	12	= 12.3 + 1.12 * (B10 − 10)
11	Newcastle United	18	= 12.3 + 1.12 * (B11 − 10)
12	Crystal Palace	12	= 12.3 + 1.12 * (B12 − 10)
13	AFC Bournemouth	11	= 12.3 + 1.12 * (B13 − 10)
14	West Ham United	17	= 12.3 + 1.12 * (B14 − 10)
15	Watford	10	= 12.3 + 1.12 * (B15 − 10)
16	Brighton & Hove Albion	13	= 12.3 + 1.12 * (B16 − 10)
17	Huddersfield Town	9	= 12.3 + 1.12 * (B17 − 10)
18	Southampton	16	= 12.3 + 1.12 * (B18 − 10)
19	Swansea City	10	= 12.3 + 1.12 * (B19 − 10)
20	Stoke City	12	= 12.3 + 1.12 * (B20 − 10)
21	West Bromwich Albion	9	= 12.3 + 1.12 * (B21 − 10)

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(c) (i) Explain, in context, what 12.3 and 1.12 in each formula for the cells in column C represent.

(2)

(ii) Work out the value of cell C2 using the formula.

(1)

(iii) Explain why the formula in cell C8 does not give the correct facility fee for Burnley.

(1)

(Total for Question 1 is 13 marks)

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2 Luke thinks that the prize money for the 2017–18 Premier League season can be modelled using

$$P_n = 40.53 - 1.93n$$

where

n is the final league position

P_n is the prize money, in £ millions, for league position n

Prior to the final game of the season, Watford could have finished anywhere from 8th to 17th.

(a) Using Luke's model, work out the difference between the prize money for finishing 8th and the prize money for finishing 17th.

(2)

The total prize money given to Premier League clubs for the 2017–2018 season predicted by this model can be written in the form

$$\sum_{n=1}^{20}(40.53 - 1.93n)$$

(b) (i) Explain, in context, what the value 20 represents.

(1)

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(ii) Use this model to calculate a prediction for the total prize money given to clubs in the Premier League at the end of the 2017–18 season.

(3)

(iii) With respect to the total prize money, assess the reliability of this model. Give a reason for your answer.

(1)

(Total for Question 2 is 7 marks)

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Refer to **data source B** in the source booklet for Question 3.

3 The number of points awarded for a full-time win is 3 points.
The number of points awarded for a full-time draw is 1 point.
No points are awarded for a full-time loss.

(a) Calculate the total number of points awarded to Manchester City for the 2018–2019 season.

(2)

During the 2018–19 season,

(b) which team, Arsenal or Leicester City, was more likely to win a game if the status at half time was a draw?
Justify your answer.

(2)

Each team played 38 games during the 2018–19 season.

For a game selected at random played by AFC Bournemouth,

(c) (i) find the probability of a full-time loss,

(1)

(ii) find the probability of a full-time loss given that AFC Bournemouth were losing at half time.

(2)

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(iii) Are the events AFC Bournemouth records a full-time loss and AFC Bournemouth losing at half time independent?
Use your answers to part (c)(i) and (c)(ii) to justify your answer.

(1)

(Total for Question 3 is 8 marks)

Refer to **data source C** in the source booklet for Question 4.

4 The fair market weekly salary for a Premier League player can be calculated using

$$F = 19.4V^{0.42}$$

where
V is the transfer value in £ millions
F is the fair market weekly salary in £ thousands

By how much was Alexis Sanchez being overpaid compared to his fair market weekly salary?

(Total for Question 4 is 2 marks)
(Total for FOOTBALL is 30 marks)

TOTAL FOR SECTION A IS 30 MARKS

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SECTION B

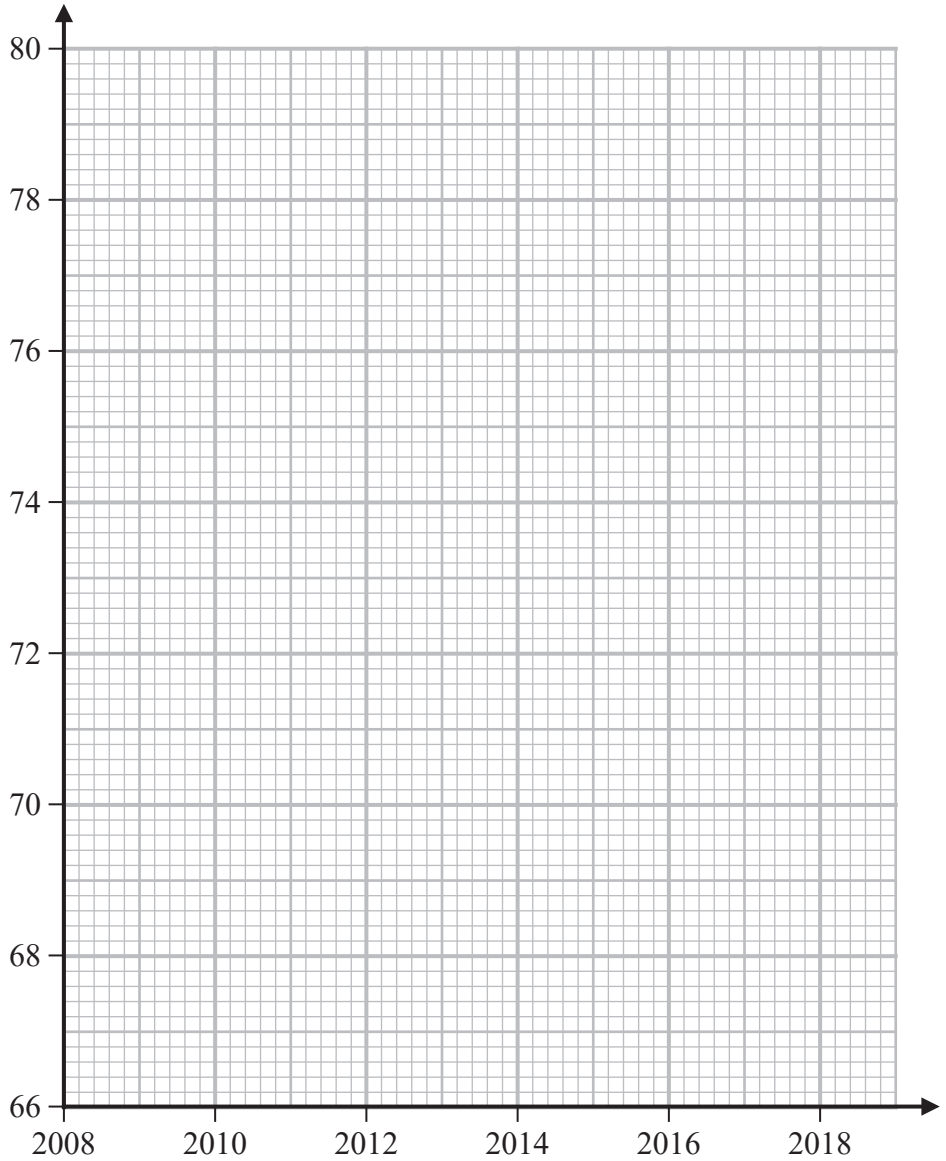
Answer ALL questions. Write your answers in the spaces provided.

URBAN v RURAL

Refer to **data source D** in the source booklet for Questions 5 and 6.

5 (a) Using the information in Table 4 in the source booklet, on the grid below draw a time series graph for the Urban data and a time series graph for the Rural data.

(4)



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An article comparing the advantages and disadvantages of rural life claims that urban areas have

- a higher level of employment
- better access to key services.

(b) Use your graph in part (a) and Figure 1 in the source booklet to evaluate these claims.

(2)

(Total for Question 5 is 6 marks)

6 Magda thinks that the number of working age people in employment in rural areas is greater than the number of working age people in employment in urban areas.

Is Magda correct?
Justify your answer.

(Total for Question 6 is 1 mark)

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Refer to **data source E** in the source booklet for Question 7.

7 Given that

$$\sum h = 2\,072\,200 \quad \text{and} \quad \sum h^2 = 466\,015\,400\,000$$

where h is the average city house price in 2017, in pounds, for the 10 regions,

(a) (i) calculate the mean and standard deviation for the average city house prices in 2017.

(3)

The average price of a house in London in 2017 was £481 556

(ii) Without doing any further calculation, what effect would including the data for London have on the mean and standard deviation found in part (a)(i)?
You must justify your answer.

(2)

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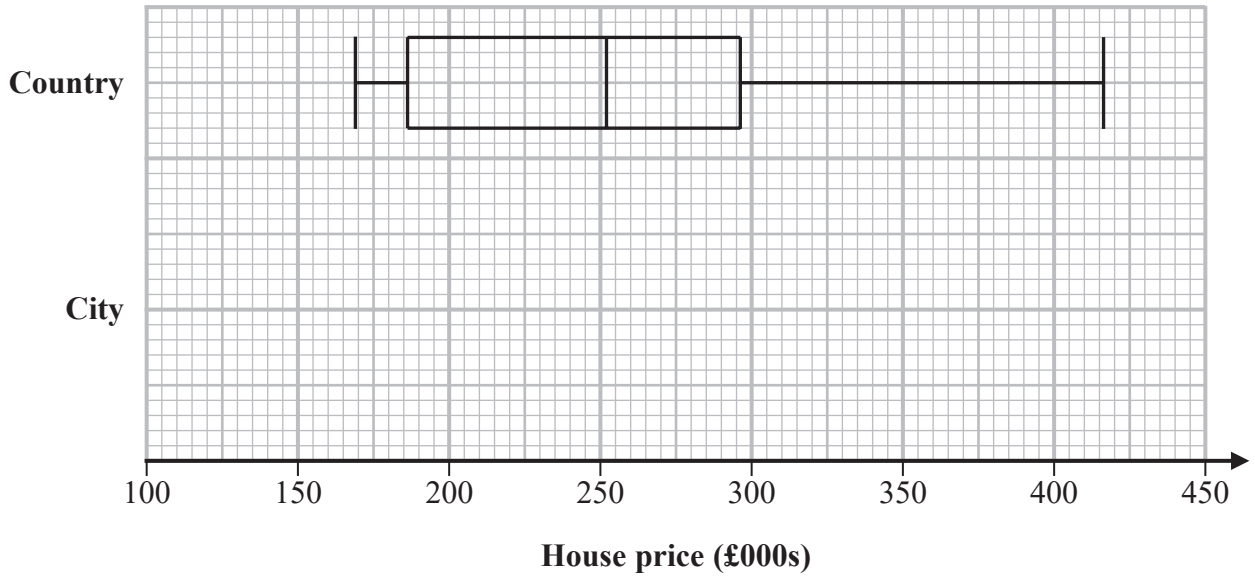
The data for the average country house price by GB region in 2017, from Table 5 in the source booklet, is summarised in the box plot below.



The table below gives information about the average city house price in 2017 from Table 5 in the source booklet.

Region	Average city house price (£)
North East	151 100
Wales	163 000
Yorkshire & the Humber	164 400
Scotland	166 700
North West	173 700
East Midlands	184 500
West Midlands	191 500
South West	240 700
East of England	305 100
South East	331 500

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An outlier is defined as any value that is

greater than the upper quartile + (1.5 × interquartile range)

or

less than the lower quartile − (1.5 × interquartile range)

(b) (i) Using the data for the average city house price by UK region in 2017, show that there are no outliers.

(3)

(ii) On the grid opposite, draw a box plot to summarise the data for the average city house price by UK region in 2017.

(3)

(c) Use the box plots to compare the two distributions.

(2)

(Total for Question 7 is 13 marks)

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Refer to **data source F** in the source booklet for Question 8.

8 (a) Use the information in Table 6 to determine if a house in an urban area, excluding London, with a price of £144 950 in 2011 was affordable for a person with gross annual earnings of £23 000

(2)

Let

r represent the rural residence based median gross annual earnings (£)
m represent the affordability ratio for rural areas

Given that

$\sum r = 217\,700$ $\sum m = 78.6$ $\sum rm = 1\,716\,260$ $\sum r^2 = 4\,750\,190\,000$ $\sum m^2 = 620.62$

(b) (i) calculate the product moment correlation coefficient between r and m for rural areas.
Give your answer correct to 3 decimal places.

(3)

(ii) Explain why your answer to part (a) supports fitting a linear regression model to this data.

(1)

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The product moment correlation coefficient between the residence based median gross annual earnings and the affordability ratio for urban areas is 0.949 correct to 3 decimal places.

(iii) Which of rural or urban would have the best fit by a linear regression model? Give a reason for your answer.

(1)

For urban areas, the equation of the regression line of y on x is

$$y = 0.000555x - 5.48$$

where

x is the urban residence based median gross annual earnings (£)
y is the affordability ratio.

Given that the urban residence based median gross annual earnings in 2025 is predicted to be £25 600

(c) use the equation of the regression line to predict the affordability ratio for an urban area in 2025.
Comment on the reliability of your answer.

(3)

(Total for Question 8 is 10 marks)
(Total for URBAN v RURAL is 30 marks)

TOTAL FOR SECTION B IS 30 MARKS
TOTAL FOR PAPER IS 60 MARKS

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Mathematics in Context

PAPER 1: Comprehension

Source booklet

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Turn over ▶

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Formulae sheet

There will be no credit for anything you write on this formulae sheet.

Mean of a frequency distribution $= \dfrac{\sum fx}{\sum f}$

Mean of a grouped frequency distribution $= \dfrac{\sum fx}{\sum f}$, where x is the mid-interval value

Variance $= \dfrac{\sum (x - \bar{x})^2}{n}$

Standard deviation (set of numbers) $\sqrt{\left[\dfrac{\sum x^2}{n} - \left(\dfrac{\sum x}{n}\right)^2\right]}$

or $\sqrt{\left[\dfrac{\sum (x - \bar{x})^2}{n}\right]}$

where $\bar{x}$ is the mean of the set of values

Standard deviation
(discrete frequency distribution) $\sqrt{\left[\dfrac{\sum fx^2}{\sum f} - \left(\dfrac{\sum fx}{\sum f}\right)^2\right]}$

or $\sqrt{\left[\dfrac{\sum f(x - \bar{x})^2}{\sum f}\right]}$

Spearman's rank correlation coefficient $1 - \dfrac{6\sum d^2}{n(n^2 - 1)}$

The product moment correlation coefficient is

$$r = \frac{S_{xy}}{\sqrt{S_{xx}S_{yy}}} = \frac{\sum x_i y_i - \frac{\left(\sum x_i\right)\left(\sum y_i\right)}{n}}{\sqrt{\left(\sum x_i^2 - \frac{\left(\sum x_i\right)^2}{n}\right)\left(\sum y_i^2 - \frac{\left(\sum y_i\right)^2}{n}\right)}}$$

The regression coefficient of y on x is $b = \frac{S_{xy}}{S_{xx}}$

Least squares regression line of y on x is $y = a + bx$ where $a = \bar{y} - b\bar{x}$

Arithmetic series

$$u_n = a + (n - 1)d$$

$$S_n = \frac{1}{2}n(a + l) = \frac{1}{2}n[2a + (n - 1)d]$$

Geometric series

$$u_n = ar^{n-1}$$

$$S_n = \frac{a(1 - r^n)}{1 - r}$$

$$S_\infty = \frac{a}{1 - r} \text{ for } |r| < 1$$

There will be no credit for anything you write in this source booklet.

SECTION A: FOOTBALL

Data source A

How Do Football Clubs Make Money?

Money from TV broadcasting rights:

Football is the most popular sport in the world. Around 700 million people around the world will watch Liverpool play Manchester United in a run-of-the-mill Premier League game. Little wonder, then, that television rights are so hotly contested between the companies that can afford to bid for them. Of all of the football leagues in the world, the Premier League is the one most people want to watch and is therefore the one that brings in the most money.

The Premier League received a total of £5.1 billion (£5 100 000 000) in TV broadcasting rights to cover games in the league from 2016-19 (this period covers three football seasons 2016–17, 2017–18 and 2018–19).

Not all the 380 Premier League games played each season were shown live on TV.

Table 1: Premier League live TV broadcasting rights

Period	Seasons	TV Broadcaster	Live games on TV per season	Total live games on TV for period	Total cost for period
1992–97	5	Sky	60	300	191 million
1997–01	4	Sky	60	240	670 million
2001–04	3	Sky	110	330	1.2 billion
2004–07	3	Sky	138	414	1.0 billion
2007–10	3	Sky/Setanta	138	414	1.7 billion
2010–13	3	Sky/ESPN	138	414	1.8 billion
2013–16	3	Sky/BT	154	462	3.0 billion
2016–19	3	Sky/BT	168	504	5.1 billion

Facility Fees:

Facility fees are paid to each club every time their games are shown live on UK television, with each club being guaranteed a total of £12.3 million for up to 10 games, PLUS an extra £1.12 million for each additional live TV game.

Prize money:

When all is said and done, football is a competitive industry. A club can finish just above the relegation zone and make a fair amount of money from TV coverage, but they will earn less than the teams above them. Why? Because for each place up in the league table you finish you earn more money. In the EPL, for example, each position you finish higher up the table is worth around £1.93 million to the football club. As the Premier League drew to a close in the 2016–17 season, Watford could have finished anywhere from 8th to 17th depending on their final game result and the final game results around them.

Table 2: Prize money and number of live TV games shown during 2017-18 season

Final League Position	Club	Prize money (£)	Number of live TV games shown
1	Manchester City	38 625 350	26
2	Manchester United	36 694 092	28
3	Tottenham Hotspur	34 762 824	25
4	Liverpool	32 831 556	28
5	Chelsea	30 900 288	26
6	Arsenal	28 959 020	28
7	Burnley	27 037 752	7
8	Everton	25 106 484	19
9	Leicester City	23 175 216	12
10	Newcastle United	21 243 948	18
11	Crystal Palace	19 312 690	12
12	AFC Bournemouth	17 381 412	11
13	West Ham United	15 450 144	17
14	Watford	13 518 876	10
15	Brighton & Hove Albion	11 587 608	13
16	Huddersfield Town	9 656 340	9
17	Southampton	7 725 072	16
18	Swansea City	5 793 804	10
19	Stoke City	3 862 536	12
20	West Bromwich Albion	1 931 268	9

The total prize money for the 2017–18 season was £405 556 280

Data source B

Table 3: Final results and status of games at half time for 2018–19 season.

2018–2019 Season		Losing at half time			Drawing at half time			Winning at half time		
Final league	Club	Final result			Final result			Final result		
		FTW	FTD	FTL	FTW	FTD	FTL	FTW	FTD	FTL
1	Manchester City	–	–	2	8	2	1	24	–	1
2	Liverpool	1	1	1	8	6	–	21	–	–
3	Chelsea	–	–	3	9	7	4	12	2	1
4	Tottenham Hotspur	2	1	5	6	–	5	15	1	3
5	Arsenal	1	2	7	11	3	3	9	2	–
6	Manchester United	2	1	6	2	6	4	15	2	–
7	Wolverhampton Wanderers	2	2	9	8	6	3	6	1	1
8	Everton	–	1	6	7	7	7	8	1	1
9	Leicester City	–	4	12	8	3	4	7	–	–
10	West Ham United	2	1	10	5	3	5	8	3	1
11	Watford	1	4	9	5	3	6	8	1	1
12	Crystal Palace	–	1	7	3	4	7	11	2	3
13	Newcastle United	2	–	8	3	6	8	7	3	1
14	AFC Bournemouth	1	1	12	3	3	7	9	2	–
15	Burnley	–	–	12	3	6	8	8	1	–
16	Southampton	1	2	10	3	6	6	5	4	1
17	Brighton & Hove Albion	–	4	14	4	4	5	5	1	1
18	Cardiff City	1	–	15	5	4	9	4	–	–
19	Fulham	1	1	20	4	2	5	2	2	1
20	Huddersfield Town	–	3	18	1	3	9	2	1	1

FTW = Full-time win FTD = Full-time draw FTL = Full-time loss

Data source C

From Sessegnon to Sanchez: How to calculate the fair market salary for EPL players.

May 24, 2019

In the 2018 January transfer window, Manchester United signed Alexis Sanchez on a four-and-a-half-year contract with a transfer value of £45 million. He had just turned 29, which is towards the end of the peak years for an elite forward. Yet Ed Woodward made him the highest paid player in the country, offering him a reported £350 000 per week, which equates to £18.2 million per year, or £82 million over the duration of the contract (before bonuses and signing-on fee).

United have undoubtedly received a spectacularly poor return on their acquisition. Granted, Sanchez has had his fair share of injuries, but it is clear that United chose to massively overpay a player whose abilities were likely to decline.

SECTION B: URBAN v RURAL

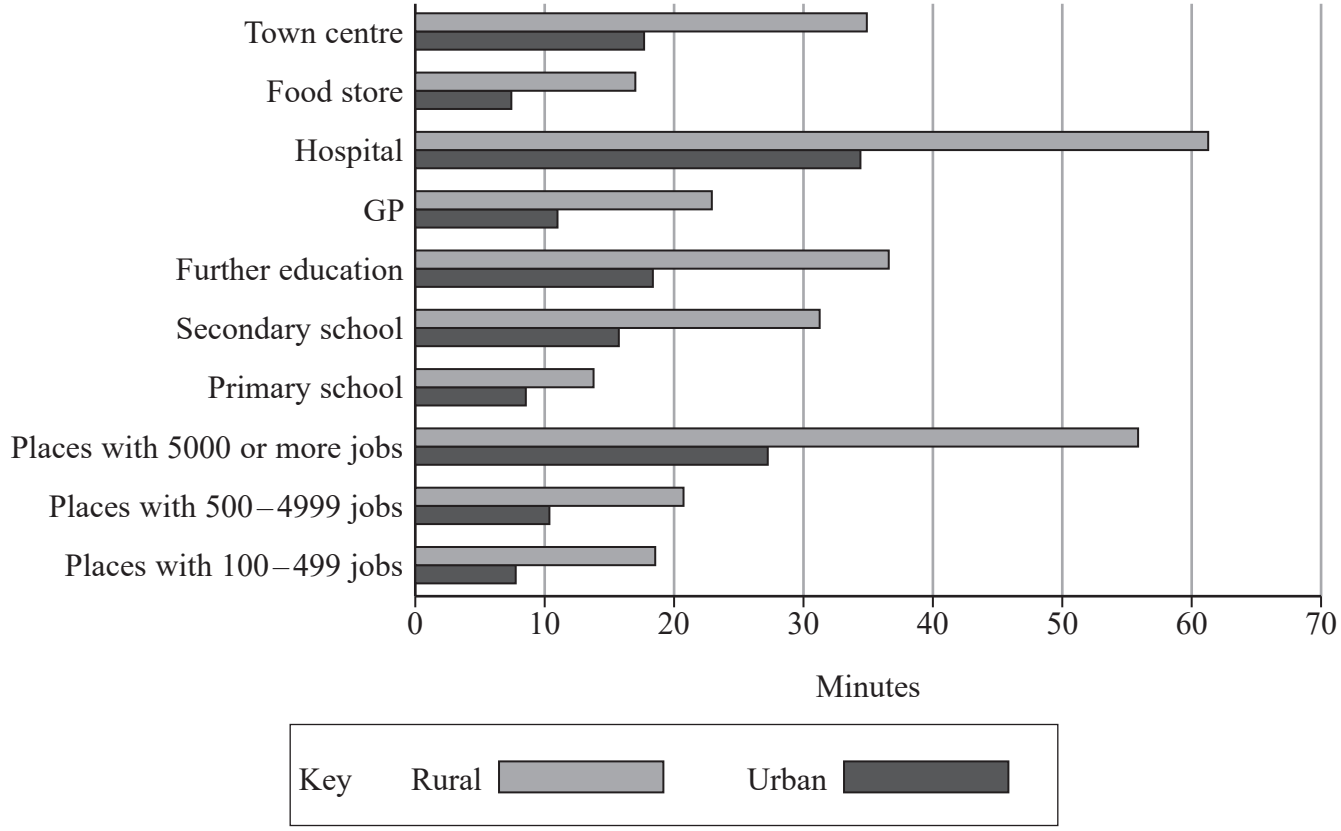
Data source D

Wherever possible, the Rural-Urban Classification is used to distinguish rural and urban areas. The Classification defines areas as rural if they fall outside of settlements with more than 10 000 resident population.

Table 4: Percentage of working age population (age 16 to 64 years) in employment, by Rural-Urban Classification in England, 2009 to 2018

Year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Urban	69.8	69.4	69.3	69.9	70.6	71.9	73.2	73.6	74.4	74.7
Rural	75.2	74.8	74.5	75.1	75.8	75.9	77.2	77.7	78.7	78.8

Figure 1: Average minimum travel time to reach the nearest key services and places of employment by public transport or walking, by Rural-Urban Classification in England, 2017.



Data source E

Table 5: Average house price by GB region 2017 (excluding London)

Region	Average country house price (£)	Average city house price (£)
North East	169 200	151 100
North West	231 400	173 700
Yorkshire & the Humber	261 400	164 400
East Midlands	239 900	184 500
West Midlands	280 800	191 500
East of England	332 800	305 100
South East	416 500	331 500
South West	296 300	240 700
Wales	183 100	163 000
Scotland	185 700	166 700

Data source F

Housing affordability

Average annual employee earnings (based on the median value of the earnings distribution) give an indication of living standards people are able to enjoy through their disposable income.

Residence based earnings measure the average annual earnings of people who work in the same area as they live.

Affordability ratios are calculated using the formula

$$\text{Affordability ratio} = \frac{\text{house price}}{\text{gross annual earnings}}$$

This ratio gives an indication of whether someone could afford to buy a house. The affordability ratio provides a value as a multiple of earnings that can be used with a house price to determine whether the house would be affordable. For example, the table below shows that in 2018, a house in a rural area was affordable if the affordability ratio was less than or equal to 8.8.

Table 6: Residence based median gross annual earnings (£) and affordability ratio in England 2009 to 2018

	Rural area		Urban area (excluding London)	
Year	**Residence based median gross annual earnings (£)**	**Affordability ratio**	**Residence based median gross annual earnings (£)**	**Affordability ratio**
2009	20 900	7.2	20 900	6.0
2010	20 700	7.7	20 800	6.3
2011	20 800	7.5	20 700	6.2
2012	21 000	7.4	21 200	6.1
2013	21 300	7.3	21 400	6.1
2014	21 500	7.7	21 600	6.4
2015	21 700	8.1	22 000	6.8
2016	22 800	8.3	22 500	7.0
2017	23 300	8.6	22 900	7.4
2018	23 700	8.8	23 500	7.5

Source information (Data was available when referenced in June 2020)

Data source A adapted from:
https://www.football-stadiums.co.uk/articles/how-do-football-clubs-make-money/
https://chelseafctransfernewsnow.blogspot.com/2019/10/chelsea-fc-revenue-breakdown.html

Data source B adapted from:
https://www.statbunker.com/competitions/LeagueTable?comp_id=614
https://www.statbunker.com/competitions/HalfTimeTableLose?comp_id=614
https://www.statbunker.com/competitions/HalfTimeTableDraw?comp_id=614
https://www.statbunker.com/competitions/HalfTimeTableWin?comp_id=614

Data source C adapted from:
http://eightyfivepoints.blogspot.com/2019/05/from-sessegnon-to-sanchez-how-to.html

Data source D adapted from:
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Data source E adapted from:
https://www.comparemymove.com/blog/your-move/city-life-vs-country-life

Data source F adapted from:
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